WHAT IS CLAIMED IS:

1. A device for emitting laser radiation as a hollow beam, said device comprising:

a cylindrical, optical fiber having a proximal end portion extending along a proximal end longitudinal axis, said proximal end portion of said fiber including a beveled proximal end surface oriented at an oblique angle relative to said proximal end longitudinal axis for receiving said laser radiation, said fiber having a distal end portion for being disposed adjacent said site and having a distal end surface for emitting said laser radiation; and

a focusing lens and mounting means for holding said lens and said fiber proximal end portion in an arrangement wherein

(A) the optic axis of said lens has one of the orientations of being (1) generally parallel to said proximal end longitudinal axis and (2) coincident with said longitudinal axis, and

(B) said lens is generally focused on said fiber proximal end surface so that laser radiation passing through said lens is transmitted into said fiber, reflected internally along the circumference of said fiber, and emitted from said fiber distal end surface as a beam in a substantially hollow cone configuration.

2. The device in accordance with claim 1 in which said fiber is fabricated from zirconium fluoride for transmitting said laser radiation from an erbium:yttrium aluminum garnet laser.

3. The device in accordance with claim 1 in which said fiber distal end portion extends along a distal end longitudinal axis and said fiber distal end surface is oriented generally perpendicular to said

distal end longitudinal axis whereby said radiation is emitted from said fiber distal end surface in a substantially hollow cone configuration.

4. The device in accordance with claim 1 in which said optical fiber is a solid and is elongate.

5. The device in accordance with claim 1 in which said lens optic axis is coincident with said proximal end longitudinal axis.

6. The device in accordance with claim 1 further including path defining means at said fiber distal end surface for defining at least one radiation transmission path including at least one mirror for reflecting said radiation to change the direction of said radiation relative to the direction of emission from said fiber distal end surface.

7. The device in accordance with claim 1 further including drive means for angularly displacing at least a portion of the distal end of said fiber about a longitudinal axis.

8. The device in accordance with claim 7 in which said drive means includes means for oscillating the distal end of said fiber length about said longitudinal axis.

9. The device in accordance with claim 8 in which said oscillating means includes

a driven ring gear mounted to the circumference of said fiber;

a drive gear engaged with said ring gear; a shaft connected to said drive gear; and means for oscillating said shaft.

10. A device for emitting laser radiation in a hollow beam to a site, said device comprising:

a cylindrical, optical fiber having a distal end portion disposed adjacent said site for emitting said laser radiation; and

coupling means integral with said fiber for transferring said radiation from a laser to the proximal end of said fiber, said coupling means including (a) a frame, (b) a proximal end portion of said fiber having a beveled proximal end surface maintained by said frame at an oblique angle relative to a selected coupling axis, and (c) a focusing lens held by said frame, said lens being held by said frame to maintain the optic axis of said lens in one of the orientations of being (1) generally parallel to said coupling axis and (2) coincident with said coupling axis, said lens being held by said frame to maintain said lens focused on said beveled proximal end surface so that laser radiation passing through said lens is transmitted into said fiber, reflected internally along the circumference of said fiber, and emitted from said fiber distal end surface as a beam in a substantially hollow cone configuration.

11. The device in accordance with claim 10 in which said fiber distal end portion extends along a distal end longitudinal axis and said fiber distal end surface is oriented generally perpendicular to said distal end longitudinal axis whereby said radiation is emitted from said fiber distal end surface in a substantially hollow cone configuration.

12. The device in accordance with claim 10 in which said fiber is fabricated from zirconium fluoride for transmitting said laser radiation from an erbium:yttrium aluminum garnet laser.

13. A device for producing a laser radiation pattern in the form of a hollow conical section at a site, said device comprising:

a cylindrical, solid, optical fiber having a proximal end portion extending along a proximal end longitudinal axis, said proximal end portion of said

fiber including a proximal end surface for receiving said laser radiation directed generally perpendicularly to said proximal end surface, said fiber having a distal end portion extending along a distal end longitudinal axis for being disposed adjacent said site and having a distal end surface for emitting said laser radiation, said distal end surface defining at least one generally conical configuration with the base of the cone oriented generally perpendicularly to said distal end longitudinal axis whereby said laser radiation that is transmitted into said fiber is emitted from said fiber distal end surface in a substantially hollow cone configuration.

14. The device in accordance with claim 13 in which said proximal end surface is oriented so that it is generally normal to said proximal end longitudinal axis, and;

said distal end surface defines a right circular cone with its vertex lying on said distal end longitudinal axis.

15. A device for emitting laser radiation in a ring-like pattern to a site with substantially uniform, angular, time averaged intensity, said device comprising:

a cylindrical, optical fiber having a proximal end portion including a proximal end surface for receiving said laser radiation, said fiber having a distal end portion for being disposed adjacent said site and having a distal end surface for emitting said laser radiation;

a laser radiation source means for directing said laser radiation through said proximal end surface into said fiber for being transmitted along said fiber, said source means and fiber operating together to effect emission of said laser radiation from said fiber distal

end surface in a substantially hollow cone configuration; and

drive means for angularly displacing at least a portion of the length of said fiber about a longitudinal axis.

16. The device in accordance with claim 15 in which said drive means includes means for oscillating said fiber length about its longitudinal axis.

17. The device in accordance with claim 16 in which said oscillating means includes

a driven ring gear mounted to the circumference of said fiber;

a drive gear engaged with said ring gear;

a shaft connected to said drive gear; and

means for oscillating said shaft.

18. A method for emitting laser radiation as a hollow beam to produce a ring-like pattern at a site, said method comprising the steps of:

(a) positioning a distal end portion of a cylindrical optical fiber relative to said site with a distal end portion having a distal end surface for emitting said laser radiation in the vicinity of said site;

(b) positioning a proximal end portion of said fiber to extend along a proximal end longitudinal axis with a beveled proximal end surface of said portion oriented at an oblique angle relative to said proximal end longitudinal axis for receiving said laser radiation; and

(c) focusing said radiation on said beveled proximal end surface through a focusing lens positioned relative to said proximal end surface in an arrangement wherein the optic axis of said lens has one of the orientations of being (1) generally parallel to said proximal end longitudinal axis and (2) coincident with

said longitudinal axis so that laser radiation passing through said lens is transmitted into said fiber, reflected internally along the circumference of said fiber, and emitted from said fiber distal end surface in a substantially hollow cone configuration.

19. The method in accordance with claim 18 in which step (a) includes providing said fiber with said fiber distal end surface oriented generally perpendicular to said distal end longitudinal axis whereby said radiation is emitted from said fiber distal end surface in a substantially hollow cone configuration.

20. The method in accordance with claim 18 in which step (c) includes positioning said lens with said optic axis oriented coincident with said proximal end longitudinal axis.

21. The method in accordance with claim 18 in which

step (a) includes providing said fiber with a core surrounded by a cladding having an index of refraction smaller than the index of refraction of said core;

step (b) includes positioning said proximal end portion with said beveled proximal end surface adjacent a medium having an index of refraction less than the index of refraction of said fiber core; and

steps (b) and (c) include positioning said fiber proximal end portion so that a plane perpendicular to said beveled proximal end surface is oriented at an acute angle relative to said proximal end longitudinal axis and wherein the product of (1) the index of refraction of said medium and (2) the sine of said acute angle is less than the square root of the difference between (1) the square of the index of refraction of the fiber core and (2) the square of the index of refraction

of the fiber cladding.

22. The method in accordance with claim 18 in which said method is employed to sculpt tissue, such as a cornea or the like, said method including at least one of the following steps:

(1) varying the intensity of the laser radiation,

(2) varying the distance of said fiber distal end surface from said tissue, and

(3) varying the period of time during which the laser radiation is emitted.

23. A method for irradiating material at a site with laser radiation, said method comprising the steps of:

(a) directing said radiation from a distal end portion of an optical fiber to irradiate said site with one of a hollow conical radiation beam and an annular cylindrical radiation beam; and

(b) sculpting said material with said beam by moving said fiber distal end and effecting the steps of determining the distance between said fiber distal end surface and said material and adjusting the radiation intensity and duration in response to said distance determination.

24. The method in accordance with claim 23 in which said step of moving said fiber distal end portion includes tilting said fiber distal end portion relative to the surface of said material to define a generally elliptical ring-like irradiation pattern on said material.

25. The method for irradiating material at a site with laser radiation, said method comprising the steps of:

(a) positioning a distal end portion of at least one optical fiber relative to said site with a

distal end portion of said fiber having a distal end surface for emitting said laser radiation in the vicinity of said site;

(b) directing said laser radiation into said optical fiber; and

(c) moving said optical fiber distal end portion adjacent the surface of said material at said site in directions generally laterally of the emitted radiation and effecting at least one of the following steps in response to at least one of the other of the following steps:

(1) controlling the intensity of the laser radiation,

(2) controlling the distance of said fiber distal end surface from said material,

(3) controlling the duration of exposure of said material to said laser radiation, and

(4) controlling the angle of said fiber distal end surface relative to the surface of said material.

26. The method in accordance with claim 25 in which step (b) includes measuring said distance by using one of techniques selected from the group of techniques consisting of: infra-red distance determination and sonar distance determination.

27. The method in accordance with claim 25 further including the steps of:

displaying the actual surface configuration of at least one planar cross section of said site on a video monitor;

drawing a desired surface configuration of said one planar cross section with a light pen; and

effecting step (c) by controlling said movement of said optical fiber distal end portion with a computer to achieve the desired zone of laser radiation.

28. The method in accordance with claim 25 in which step (a) includes orienting a plurality of solid optical fibers with beveled distal end surfaces in an annular bundle configuration with the distal end portions of said solid optical fibers positioned in the vicinity of said site with the beveled end surfaces oriented at an angle to the surface of said material at said site.

29. The method in accordance with claim 25 in which step (a) includes positioning a single, hollow, optical fiber with a beveled distal end surface oriented at an angle to the surface of said material at said site.

30. A method for shaping a cornea, which method comprises:

generating a hollow beam of laser energy having a wavelength in the range of about 0.15 μm to about 11 μm; and

applying at least a portion of the generated hollow beam to a selected region of the cornea and irradiating said region for a time period sufficient to change the refractive characteristic of the cornea.